The Cold Air Aloft Problem: Applications of Temperature Soundings in High Latitude Regions for Aviation

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BACKGROUND

- Cold Air Aloft (CAA; -65°C and below) is potentially hazardous to aircraft due to the threat of fuel freezing at these extreme temperatures
- The Anchorage, Alaska Center Weather Service Unit (CWSU; Fig. 1) provides Meteorological Impact Statements (MIS; Fig. 1) to Air Traffic Controllers to direct flights around Cold Air Aloft

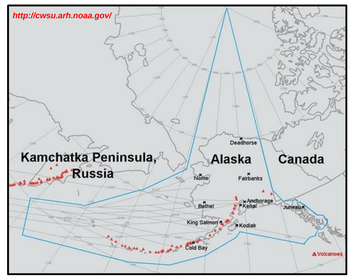

Fig. 1. Anchorage, AK CWSU domain

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FAAK20 KZAN 121458
ZAN MIS 01 VALID 121500-130300
...FOR ATC PLANNING PURPOSES ONLY...
COLD AIR ALOFT
FROM 185NE SCC-65NE ORT-55SW ENN-110NW BRW-185NE SCC
TEMPS -65C OR LESS FM FL350-400. AREA MOVG NE 40 KTS.
CMW NOV 14
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Lat/Lon Extent of Cold Air from soundings, aircraft reports, model

Vertical Extent of Cold Air from soundings/aircraft reports/model

Motion determined from model data

Fig. 2. Sample MIS product issued by CWSU defining the 3D extent of potentially hazardous cold air.

- In data sparse Alaska, forecasters traditionally rely on analysis/model fields, limited radiosonde observations, and pilot reports to guess the 3D extent of the Cold Air Aloft
- Use of satellite observations provides an opportunity for forecasters to observe the 3D extent of the Cold Air Aloft in real-time where conventional observations are lacking
- Forecasters at the CWSU have expressed the need for an observational product from satellites that can be used to give confidence in the model output

DETECTION OF CAA FEATURES FROM HYPERSPECTRAL IR

- Climatology suggests that these CAA features are observed at typical flight levels (around 200 hPa) in the sounder data at relatively high frequencies during the winter months (Fig. 3) especially over Southern Alaska and into CONUS
- CrIS temperature retrievals from NUCAPS depict the spatial extent of the coldest air very well compared to model reanalysis (Fig. 4)
- However, because typical flight levels are in regions just below the tropopause, there is a tendency for the satellite sounder to shift the coldest air (Fig. 5) and a warm bias in that region (Fig. 6)

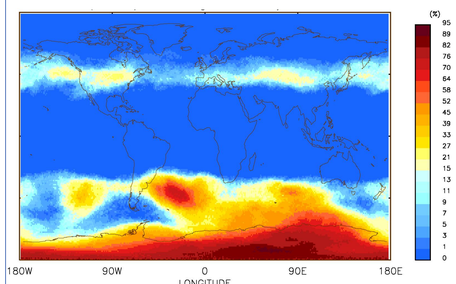


Fig. 3. Probability of observing T ≤ -60ºC in Atmospheric Infrared Sounder data at 200 hPa from 1 January 2015 to 4 April 2015.

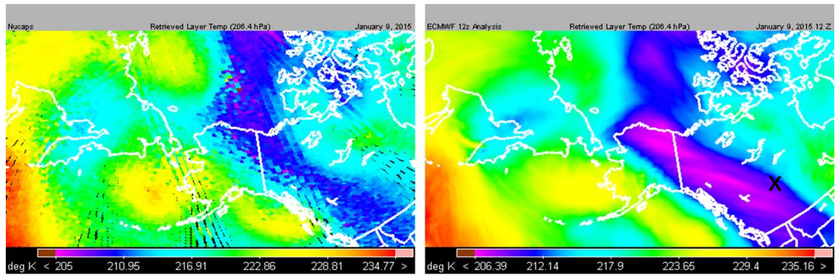


Fig. 4. 200 hPa NUCAPS MW+IR soundings (left) and ECMWF 200 hPa reanalysis at 1200 UTC on 9 January 2015 during a CAA outbreak across eastern Alaska and western Canada. The "X" denotes the location of the sounding shown in Fig. 5.

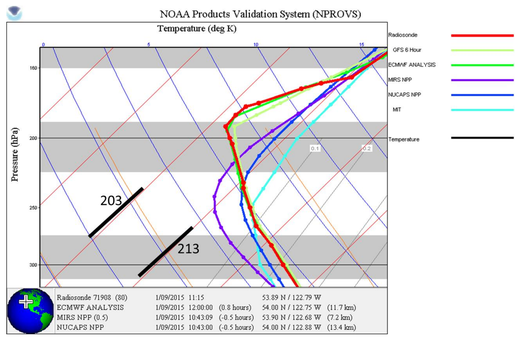


Fig. 5. Comparison of observed and modeled vertical soundings over western Canada in core of CAA ("X" in Fig. 4) at 1200 UTC on 9 January 2015. Note that coldest air in CrIS data is lower in the atmosphere and slightly warmer than observed by radiosonde.

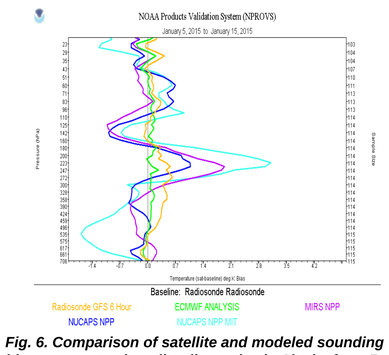
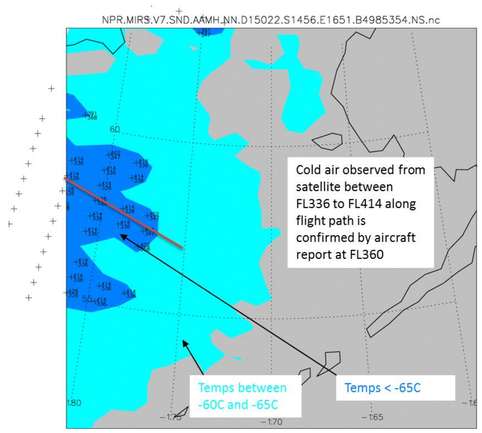


Fig. 6. Comparison of satellite and modeled sounding biases compared to all radiosondes in Alaska from 5 to 15 January 2015. Again, note warm bias at around 200 hPa in all datasets.

DEVELOPMENT OF VISUALIZATION OF CAA FOR AWIPS II

- Current implementation of NUCAPS as Skew-Ts in AWIPS II is difficult to use for detecting the extent of air masses as one has to click on lots of soundings and then synthesize that data to make decisions
- Forecasters at CWSU requested a gridded NUCAPS product in AWIPS II with a color-curve enhancement that will flag regions of cold air below -60ºC and will enable plan view plots and vertical cross sections
- Visualization was developed based on web graphics created at CIRA (Fig. 7)
  - NOAA-18 High Resolution Infrared Radiation Sounder (HIRS) instrument determined blob of temperatures less than -65ºC between of 50 and 60ºN latitude and west of 175ºW longitude between FL336 and FL414
  - Aircraft reported temperatures at -65ºC and -66ºC from latitude/longitude 54N/175W to 56N/177E at FL360 at 1642z on 22 January
  - Most other aircraft were flying at FL330 or lower in that area
- Gridded HDF output from CIMSS *polar2grid* software is converted to a GRIB2 format for visualization within the Volume Browser in AWIPS II (Figure 8)

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FAAK20 KZAN 221521
ZAN MIS 03 VALID 221530-230330
...FOR ATC PLANNING PURPOSES ONLY...
FROM 700W HPB-45NW HPB-130N DUT-525W
SYA-700W HPB
COLD AIR ALOFT
TEMPS -65C OR LESS FM FL330-FL360. STNR.
NC.
CMW JAN 15
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Fig. 7. Example of CAA visualization from CIRA website from which AWIPS II visualization was designed (top). Blue shaded areas depict regions where satellite detects air below -60oC. Crosses represent individual footprints with annotated top and bottom flight levels where temperatures are below -65oC. Red line depicts a flight track that verified the 3D extent of the CAA shown by the satellite. Text is the CAA MIS issued by the CWSU for this event based on the aircraft report.

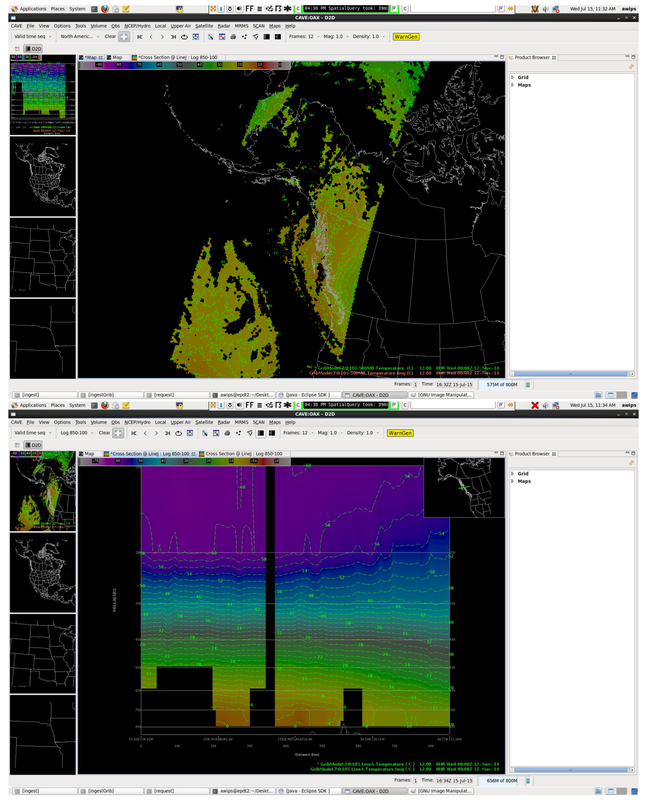

Fig. 8. CAA Visualizations in AWIPS II using sample 8-level Dual Regression gridded product

SUMMARY

- A collaborative effort between SPoRT, CIMSS, CIRA, GINA, and NOAA has produced a unique visualization of gridded NUCAPS output in AWIPS II to aid aviation forecasters in Alaska with the detection of the 3D extent of cold air aloft that can be hazardous to aircraft

FUTURE WORK

- CIMSS to amend *polar2grid* software within CSPP to generate gridded NUCAPS soundings
- GINA to disseminate gridded NUCAPS to SPoRT for formatting to GRIB2 format and ingest into the AWIPS II systems at the Alaska CWSU
- CIRA to integrate gridded NUCAPS into suite of web graphics for the CWSU to include in public products
- Development of training to communicate CAA forecast challenge, sounder strengths and limitations, and use cases is underway
- Targeted assessment period planned for winter 2015/16 to evaluate the operational utility of visualization

ACKNOWLEDGMENTS

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